von Thaden, T. L., Kessel, J, and Ruengvisesh, D. (2008). Measuring Indicators of Safety Culture in a Major European Airline's Flight Operations Department. The Proceedings of the 8th International Symposium of the Australian Aviation Psychology Association. Novotel Brighton Beach, Sydney, 8 - 11 April.

Measuring Indicators of Safety Culture in a Major European Airline's Flight Operations Department

TERRY L. VON THADEN[1], JAN KESSEL[2], AND DECHYING RUENGVISESH[1]

[1]*Human Factors Division, University of Illinois at Urbana-Champaign, USA*
[2]*Department of Aviation Systems Engineering and Management, University of Bremen, FRG*

Abstract

Safety and reliability are the basis upon which commercial airlines provide services worldwide. The safety standard in European aviation today is already exceptionally high. Safety risks are largely minimized through the thorough review of the aircraft on the ground, the attention to permanent airworthiness documentation, the redundancy of the systems, sophisticated equipment and procedures. Incidents or accidents, circumstances in which persons or materials suffer damage, in airline transportation are relatively rare due to the diversity and complexity of the redundant technical and organisational processes put in place to assuage them. Nevertheless, the International Civil Aviation Organisation has identified a number of areas in which certain elements of aviation safety programs may be further supported and enhanced, through Safety Management Systems (SMS). One important tenet of SMS is the attention to organisational safety culture. The present analysis represents research performed using the University of Illinois' Commercial Aviation Safety Survey to study the organisational indicators of safety within a major European air carrier's flight operations. Results indicate a positive, effective safety culture within the organisation, with very few negative indicators.

Introduction

Great progress has been made to significantly reduce the rate of aviation accidents over the past 50 years through advances in engineering, training, selection, and other scientific interventions. Yet in recent decades, the significant reductions realized earlier have come to a near standstill. The reported rate of commercial aviation accidents, due at least in part to human error has remained constant at ~80% (Wiegmann & Shappell, 2003). With this in mind, air traffic globally is forecast to continually and steadily increase operations over the next two decades. Airbus projects that the world's passenger traffic will increase 4.9% annually, nearly tripling that of today by circa 2026 (Doran, 2008). If this forecast is to be believed, for one major European air carrier alone the number of passengers carried in 2026 would be at least 100 million annually. Needless to say, the objective of minimizing disruption and incidents during this growth period will most likely be achieved if the absolute number of disturbances remains constant or reduces. This requires a reduction of the relative fault rate which represents an enormous challenge for the airlines and their regulators worldwide.

The exploration of accident cause factors due to human error is gaining maturity and has been integral providing detailed analysis of the causes of accidents so that we may learn. These efforts have, among others, lead to the improved efficient training of air crews in such areas a multi crew pilot licenses, for example (JAA, 2006). But if we are to promote the continued reduction of the accident rate due to human error, the coordination of systematic organisational safety efforts must accelerate. Accident research has shown that the human failure of the front line operator, in many accidents, represents only a superficial cause (cf. Reason, 1990; Helmreich & Merritt, 1998; Wiegmann & Shappell, 2003; von Thaden, Wiegmann & Shappell, 2006). An active failure is considered unsafe behaviour, which influences the direct safety of the system. Upon close analysis, the errant human behaviour often derives from external, underlying factors that have propagated through the system over a period of time. For example, technical advances, such as an electronic flight bag, have upon occasion not contained critical data needed for an approach, but this is only revealed

to the cockpit crew in the act of performing the manoeuvre. These latent errors experience a time delay between when the error was generated to its emergence. These latent defects tend to reveal themselves coupled with other active faults, linking together to result in an accident with far greater consequences than would have resulted from an errant behaviour alone. Latent factors must be explored through the lens of organisational oversight if we are to reduce accidents.

In their investigation of organisational factors in aviation accidents, von Thaden, Wiegmann & Shappell, (2006), discovered problems in the operational procedures and guidelines for large and small operators alike. While a number of organisational shortcomings were revealed, in smaller operations problems in the areas of training, leadership and quality control were prominent problems, while in the larger (major) airlines these problems tended to centre on the exchange of information, communication and documentation. Understanding the organisational underpinnings of error in commercial aviation allows researchers to then focus on the culture of the organisations that appear to perpetuate these problems and seek areas mitigate safety problems.

Organisational Safety Culture

Interest in organisational safety culture has given rise to widespread definitions and measures of the construct of safety culture (Wiegmann, Zhang & von Thaden, 2001). These differences are largely due to the type of industry and the context of the relative safety area studied within these industries (e.g., high risk safety critical industries, occupational health factors, factory operations, etc.). Safety culture is typically defined as a group-level construct with various dimensions pertaining to the occupation studied. For example, Flin, Mearns, O'Connor, and Bryden (1998) found common themes over 18 safety climate surveys suggesting that the most typically assessed dimensions are related to management, safety system, and risk, followed by work pressure and competence; noting that procedures and rules should also receive attention. Lee and Harrison (2000) identified employees' negative attitudes as significantly associated with the likelihood of an accident. Neal and Griffin (2006) verified the latent effects of this same concept between safety climate and accident rates demonstrating that group safety climate shapes individual safety motivation, which in turn influences individual safety behaviour, and thus accident rates. Guldenmund (2007) has also identified 9 dimensions related to organisational policy: hardware, maintenance, manpower planning, risks, procedures, competence, commitment, communication, and change monitoring.

Safety culture has previously been defined as the enduring value and prioritization of worker and public safety by each member of each group and in every level of an organisation. It refers to the extent to which individuals and groups will commit to personal responsibility for safety; act to preserve, enhance and communicate safety concerns; strive to actively learn, adapt and modify (both individual and organisational) behaviour based on lessons learned from mistakes; and strive to be honoured in association with these values (adapted from Wiegmann, von Thaden, Mitchell & Sharma, 2001). The definition combines key issues such as personal commitment, responsibility, communication, and learning in ways that are strongly influenced by upper-level management, but also influence the behaviour of everyone in the organisation (cf. Wiegmann, Zhang, von Thaden, Sharma, and Gibbons, 2004). It implies that a safety culture in any organisation basically exists, but is expressed in varying quality. Safety culture represents a complex understanding wherein an organisation must evaluate its strengths and weaknesses to promote the creation of a consistent, positive safety culture. To promote a strong culture of safety, an organisation must proactively train the positive characteristics and inform the community of the priority of safety in operations. Therefore indicators of safety culture must be specifically indentified and clearly measured for any training or procedural changes to be introduced and accepted into the organisation.

The Commercial Aviation Safety Survey

Researchers at The University of Illinois at Urbana-Champaign (UIUC) have developed a measure associated with safety culture in high reliability organisations. Since circa 2000 the Commercial Aviation Safety Survey (CASS) has been distributed globally in the aviation industry to large and small airlines and repair stations alike. The instrument has been refined to a four-factor model reflecting Organisational Commitment, Formal Safety System, Operations Interactions, and Informal Safety System (Figure 1) (Gibbons, von Thaden & Wiegmann, 2004; Gibbons, von Thaden & Wiegmann, 2006; von Thaden, Gibbons & Li, 2007, von Thaden, 2008). The CASS identifies the current state, as well as the strengths and weaknesses, of the safety culture in an organisation.

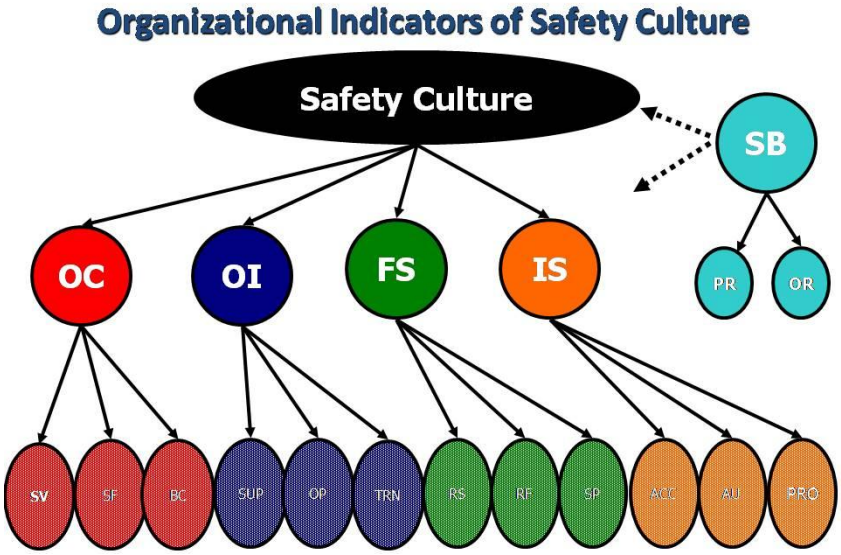


Figure 1. Four factor model of safety culture in the Commercial Aviation Safety Survey (von Thaden, 2008.)

Dimensions of Safety Culture

Organisational Commitment (OC) is reflected in three major areas: Safety Values (SV) the attitudes and values regarding safety expressed, in words and actions, by leadership; Safety Fundamentals (SF) the compliance with regulated aspects of safety such as training requirements, manuals, etc.; and Going Beyond Compliance (GBC) wherein priority is given to safety in the allocation of company resources (e.g., equipment, personnel time) even though they are not required by regulations.

Operations Interactions (OI) is reflected in the working relationships between pilots and middle management, supervisors, and other distributed operations personnel (e.g., chief pilots, instructors/trainers, ground agents, flight attendants, maintenance, dispatch, etc.) that take into account involvement in and concern for safety on their part. This entails the priority given to safety by operations personnel and their regard for the actual risks and issues associated with flying the line.

Formal Safety System (FS) is reflected in three areas: Reporting System (RS) which refers to the accessibility, familiarity, and actual use of the airline's formal safety reporting program; Response and Feedback (RF) which entails the timeliness and appropriateness of management responses to reported safety information and dissemination of safety information to employees; and Safety Personnel (SP) the perceived effectiveness of and respect for persons in formal safety roles (e.g., Safety Officer, VP of Safety).

Informal Safety System (IS) is reflected in Accountability (ACC) the consistency and appropriateness with which individuals are held accountable for unsafe behaviour; Authority (AU) which entails employee involvement and empowerment in safety decision making; and Professionalism (PRO) reflected in areas such as peer culture for safety, pilot professionalism.

The above factors are the correlated with Safety Behaviour (SB) which includes the perception of the organisation's risk (OR) and individual personal risk (PR)

Method and Results

The CASS was used to survey a major European Air Carrier's flight operations department (N=3674). The anonymous voluntary survey was delivered online in the English language. Participants were assured of the confidentiality of their responses. Participants included line pilot through leadership positions. UIUC randomly generated passwords which were distributed to employees' mailboxes with the Internet address of the survey. Once securely logged in, employees responded to items regarding normal operations, using a seven point Lickert scale. There was also an area for respondents to include their comments. The data were captured on a secure server housed at UIUC.

Respondents. The survey response was 1565, resulting in a calculated return rate of 40.34%. Additionally, approximately 10% of the participants provided comments in the areas provided on the web form. Approximately 44% of the respondents identified themselves as Captain, 38% as First

Officer, 14% as Senior First Officer, 1% as Management, and 3% as other. Age ranges were well distributed throughout the population with 33% of respondents indicating an age range of 31-40, 28% indicating ages of 20-30, 25% 41-60, and 15% 51-60 years old.

Scale Reliability. A common measure of reliability is the Guttman-Cronbach alpha coefficient (Cronbach, 1951; McDonald, 1999), which is based on the correlations between the items in a scale and the length of the scale. The value of alpha can range from zero to one, but standards regarding its size depend on a number of factors, including the nature of the research and the degree to which scale items are redundant (John & Benet-Martinez, 2000). Usually, alpha coefficients at or above 0.70 are acceptable. The obtained values of alpha for all four scales regarding the airline's survey demonstrate more than adequate reliability with total $\alpha = 0.97$.

Dimension Scores. Scores for the airline were calculated for each of the four safety culture dimensions as the mean of participants' responses to the items. Values of negatively worded items were reverse-coded so that standardized and comparable readings could be obtained from the data. Thus the scale reflects that higher measurement values represent higher quality of safety culture in this feature. The scores are as follows: Organizational Commitment, $M = 4.75$; Operations Interactions, $M = 5.27$; Formal Safety System, $M = 5.17$; and Informal Safety System, $M = 4.79$. The mean score for the airline on the four dimensions is above the neutral point of 4.0, indicating that respondents hold a positive opinion of the airline's flight operations' safety culture in regard to each dimension. No dimension received a perfect score from any employee (i.e., endorsing the appropriate "strongly agree/disagree" alternative for all items in the scale).

Subfactors of Safety Culture

The summary of the results indicates that overall the airline has strong positive indicators of safety culture, with few negative items. The pattern of the scale scores suggests different areas of strength and weakness for the airline, implying that the actual safety culture experienced by employees may vary in some areas. Items with negative scores are identified in the Safety Values of leadership, Going Beyond Compliance, Ground Handling Operations, Reporting System, and Accountability. Exceptionally positive scales include Instructors/Trainers, Operations Control, Maintenance, Flight Attendants, Safety Personnel, and Safety Behaviour. All scales were appropriately negatively correlated with respondent's perceptions of risk at the airline.

Organisational Commitment

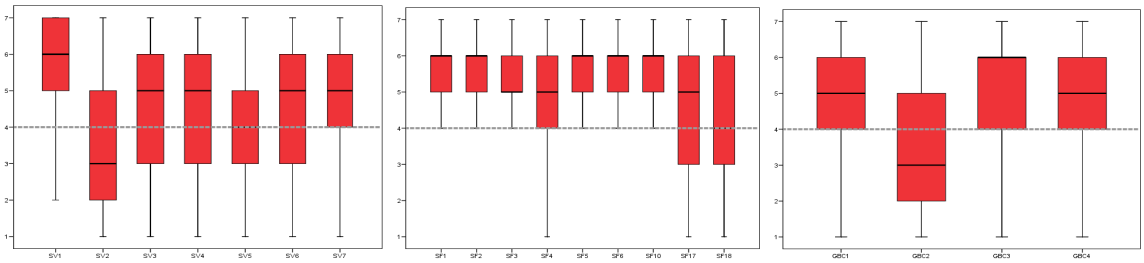
Organisational Commitment items contain the three scales of Safety Values, Safety Fundamentals, and Going Beyond Compliance. Below is a condensed summary of the mean scores. Figure 2 contains boxplot depictions of the three scales in this category. A boxplot is a graphical depiction of summary information, which consists of the smallest observation, lower quartile (Q1), median, upper quartile (Q3), and largest observation. Boxplots visually portray different populations without assumptions about the distribution. The spacing between the parts of the box indicates variance, skew, and outlier identification. The box itself contains the middle 50% of the data. The upper hinge of the box indicates the 75th percentile, and the lower hinge indicates the 25th percentile. The line in the box indicates the median data value. If the median line within the box is not equidistant from the hinges, then the data is skewed.

Safety Values. There are seven items included in the Safety Values scale. While the identification of safety as a core value scored the highest in this scale (5.84), there is a perception that leadership is more concerned with making money than being safe (3.73), and may be willing to cut corners where safety is concerned (3.96).

Safety Fundamentals. There are nine items included in the Safety Fundamentals scale All items in this scale scored above the scale midpoint, with the highest scoring items reflected in checklists and procedures as being easy to understand (5.53), documentation and record keeping taken seriously (5.53), and manuals carefully kept up to date (5.44). The lowest scoring item in this scale had to do with the suitability of the electronic interface for flight manuals (4.06).

Going Beyond Compliance. There are four items included in the Going Beyond Compliance scale. The highest scoring item reflects that airline leadership does not try to get around safety requirements if the opportunity arises (5.29). The lowest scoring item reflects that the airline appears to schedule

the pilots as much as legally possible with little concern for pilot fatigue or sleep schedule (3.44).



Safety Values *Safety Fundamentals* *Going Beyond Compliance*

Figure 2. Boxplots of responses to each item in Organizational Commitment; Scales from left to right include: Safety Values, Safety Fundamentals, and Going Beyond Compliance scales.

Operations Interactions

Operations Interactions contains the seven scales of Fleet Management, Dispatch, Ground Handling, Instructors/Trainers, Operations Control, Maintenance, and Flight Attendants. Below is a condensed summary of the mean scores. Figure 3 contains boxplots of the scales in this category.

Fleet Management. All four items in the Fleet Management scale scored above the scale midpoint, with the highest scoring items reflected in the dedication of fleet management to the performance of safe flight operations (5.47). The lowest scoring item in this scale pertained to fleet management contacting pilots to proactively discuss safety issues (4.47).

Dispatch. There are ten items included in the Dispatch scale. All items in this scale scored above the scale midpoint with minimal variance in the responses. The highest scoring item reflected the suitability of information in the online briefing (5.70). The next highest scoring item suggests the pilots feel dispatch operators are highly qualified and competent in their duties (5.50). The lowest scoring item in this scale pertained to the misuse of minimum equipment list items (4.60).

Ground Handling Operations. There are twelve items included in the Ground Handling scale. The highest scoring item in this scale reflects that pilots do not feel the aircraft is at high risk of suffering ground damage each time it is released for pushback (5.53), nor do they perceive miscommunication between ground handlers and pilots as a frequent cause of incidents (5.24). The lowest scoring items in this scale reflect that ground agents may not be as highly qualified and competent as pilots would wish (3.64) and may not communicate clearly and effectively with pilots (3.68).

Instructor/Trainers. There are five items included in the Instructors/Trainers scale. All items in this scale scored well above the scale midpoint, with the highest scoring items reflected in the fact that instructors/trainers teach the requirements without shortcuts to the safety system (6.31) and that safety is consistently emphasized during training (6.14). The materials are not perceived as trivial (5.53) and pilots are prepared for various situations, not just for passing a check ride (5.69).

Operations Control. There are eight items included in the Operations Control scale. All items in this scale scored well above the scale midpoint, with the highest scoring items reflecting the Operations control is available when needed (5.79) and that they are perceived as highly qualified and competent (5.70). Operations Control shows respect to flight crews (5.23) and they will not take a chance with safety when it comes to the disposition of a flight (5.08).

Maintenance. There are eleven items included in the Maintenance scale. All items in this scale scored well above the scale midpoint, with the highest scoring items reflecting that pilots will not hesitate to contact maintenance for opinions on questionable items (6.04) and that maintenance technicians are perceived as highly qualified and competent (5.93). Maintenance is seen as responsive to pilots' concerns about safety (5.66) and they communicate clearly and affectively with the flight crews (5.35). The lowest score reflects flight crews provide thorough discrepancy write-ups (5.03).

Flight Attendants. There are ten items included in the Flight Attendant scale. All items in this scale scored above the scale midpoint, with the highest scoring items reflecting that pilots support flight attendants' assessment of passenger safety (e.g. unruly passengers, sick passengers) (5.93) and that pilots are responsive the flight attendants concerns about safety (5.91). Pilots report that they routinely keep flight attendants up to date with flight operational information (5.51) and that they respect flight attendants (5.17). Pilots feel flight attendants are highly qualified and competent in their jobs (4.55).

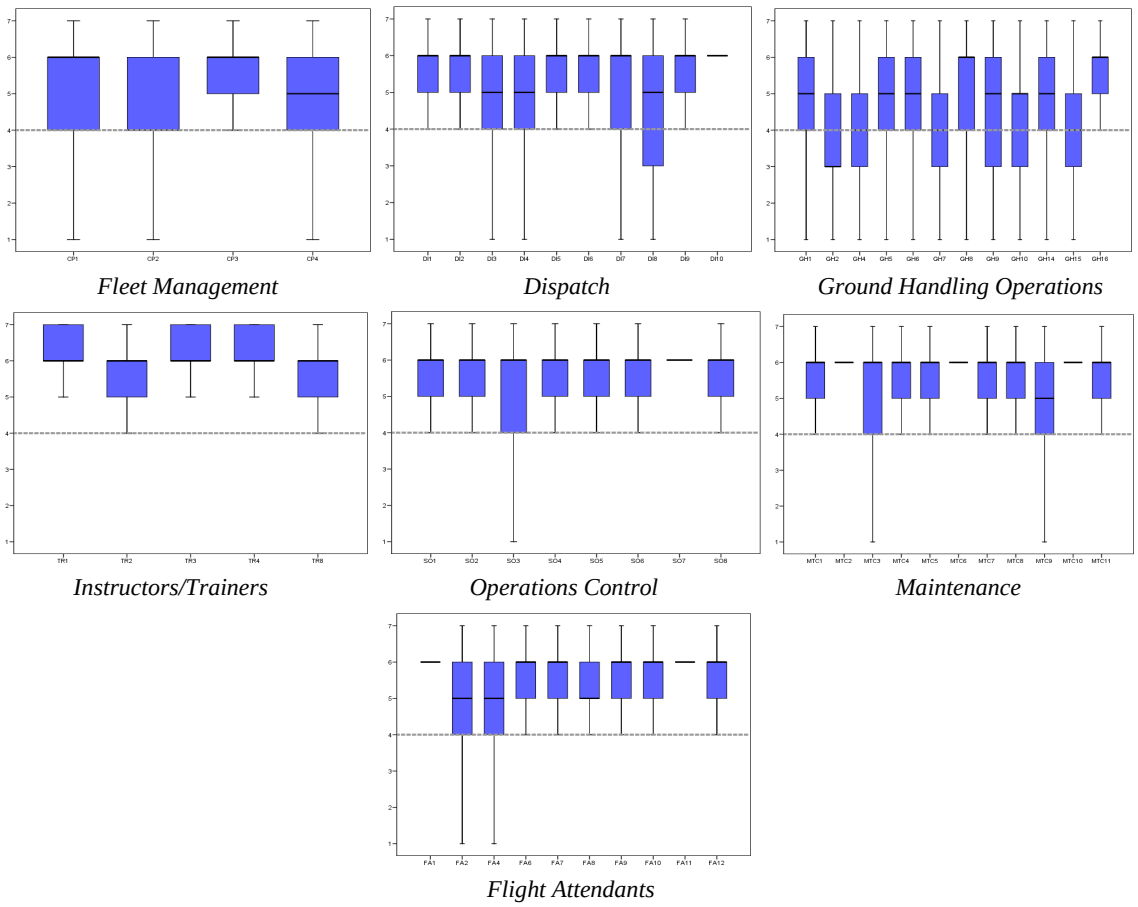


Figure 3. Boxplots of responses to each item in Operations Interactions. Scales from left to right include (beginning top left): Fleet Management, Dispatch, Ground Handling, Instructors/Trainers, Operations Control, Maintenance, and Flight Attendants.

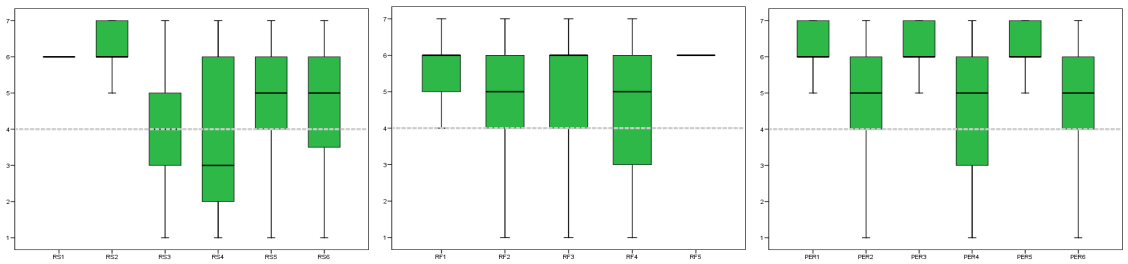
Formal Safety System

Formal Safety System contains the three scales of Reporting Systems, Response and Feedback, and Safety Personnel. Below is a condensed summary of the mean scores. Figure 4 contains boxplots of the scales in this category.

Reporting System. There are six items included in the Reporting System scale. The highest scoring item in this scale reflects that pilots can report safety discrepancies without fear of negative repercussions (6.19) and that the safety reporting system is convenient and easy to use (5.80). The lowest scoring items reflect that pilots are not too willing to report information regarding the marginal performance or unsafe actions of other pilots (3.98) and that they don't bother reporting near misses or close calls since no real damage was done (3.73).

Response and Feedback. There are five items included in the Response and Feedback scale. All items scored above the scale midpoint. The highest scoring item in this scale reflects that the airline routinely disseminates safety data information through various articles, so lessons may be learned from events (5.78) and that important safety issues raised by pilots are communicated regularly back to the pilots (5.66). Pilots also indicate that when a pilot reports a safety problem, it is corrected in a timely manner (4.55) and the airline does not overlook routine safety problems in favour of keeping track of only major issues (4.44).

Safety Personnel. There are six items included in the Safety Personnel scale. All items scored above the scale midpoint. The highest scoring item in this scale reflects that the safety personnel have a clear understanding of the risks involved in flying the line (6.15) and they demonstrate a consistent safety commitment (6.11). They are perceived as having a strong influence on flight operations (4.95).



Reporting Systems *Response and Feedback* *Safety Personnel*

Figure 4. Boxplots of responses to each item in Formal Safety Systems. Scales from left to right include Reporting Systems, Response and Feedback, and Safety Personnel.

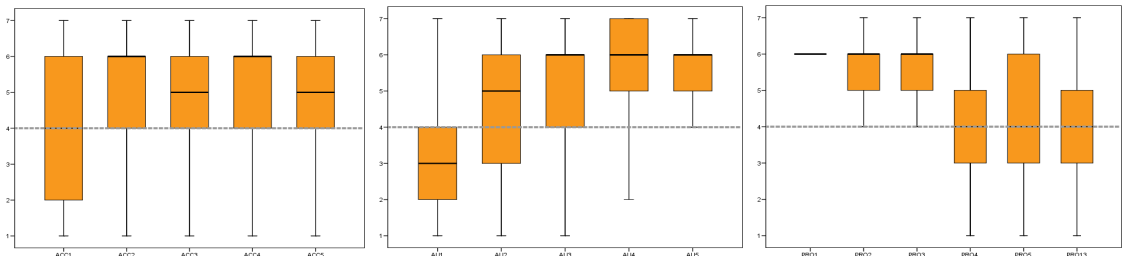
Informal Safety System

Informal Safety System contains the three scales of Accountability, Authority, and Professionalism. Below is a condensed summary of the mean scores. Figure 5 contains boxplots of the scales in this category.

Accountability. There are five items included in the Accountability scale. The highest scoring item in this scale reflects that standards of accountability are consistently applied to all pilots in the airline (5.24) and that the investigation process into possible unsafe behaviour is fair (5.18). Pilots report that management does not immediately blame the pilot in an accident or incident (4.80). The lowest scoring item reflects the perception that fleet management shows favouritism to certain pilots (3.90).

Pilot's Authority. There are five items included in the Pilots' Authority scale. The highest scoring items in this scale reflects that pilots feel they have the authority to make decisions that affect the safety of normal flight operations (5.69) and that management rarely questions a pilot's decision to delay a flight for a safety concern (5.46). The lowest scoring item reflects the perception that pilots are rarely asked for input when procedures are developed or changed (3.11).

Professionalism. There are six items included in the Professionalism scale. The highest scoring items in this scale reflects that pilots view the airline's safety record as their own and take pride in it (5.81) and Pilots with less seniority are willing to speak up regarding flight safety issues (5.34). The lowest scoring item reflects the perception that decisions made by training/check pilots are difficult to challenge (4.00).



Accountability *Pilots' Authority* *Professionalism*

Figure 5. Boxplots of responses to each item in Informal Safety Systems. Scales from left to right include Accountability, Pilots' Authority, and Professionalism.

Safety Behaviour

There are ten items included in the Personal Risk measure which was designed to assess the relative frequency of individual risk behaviours within the airline. All items are above the scale midpoint and reflect that pilots do not take unnecessary risks and are proactive in their individual behaviours at the airline. These are reflected in such areas as pilots do not show up for work under the influence of alcohol or drugs (6.79), they do not feel pressured to fly company aircraft they believe unsafe or non airworthy (6.76). The lowest scoring item reflects that pilots may be reporting for duty when fatigued, ill, or under unusual stress (4.78). The mean scores for Organisational Risk reflect pilots are moderately cautious that pilots believe the airline could possibly be involved in an incident over the next twelve months (4.15), but are comfortable allowing family to fly the airline (6.65).

Conclusion

The airline studied has an exceptional safety record. The data here reflect pilots with high safety motivations thus reflecting that employees' attitudes are significantly associated with the likelihood of an accident. While the organisation demonstrates positive and effective overall organisational indicators of safety culture, there are specific areas related to the values and fundamentals of the organisation that impinge on the pilots' consistent demonstration of safety culture. These items are highly correlated with organisational commitment. Leadership appear committed to the same high level of values, yet there are a few areas in which the message seems obscured from leadership such as: cutting corners, scheduling, management misuse of the reporting system, and pilot input into system developments or changes. With minor procedural changes, leadership can improve upon indicated weaknesses and the pilots' inconsistent experience and further enhance safety behaviours at the airline.

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